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The Arizona Research Coordinating Unit has concentrated its efforts during the past 18 months on a study of engineering technology which was published in March of 1968. A second major project is a study of vocational-technical education in the state to be used as a basis for future planning. Other activities included assistance with several research projects in junior colleges and high schools, assistance in research design, and proposal writing, collection and dissemination of research materials, development of a system of identifying research needs and priorities through a State Coordinating Council, and assisting the State Department of Vocational Education in setting up and operating an automatic data processing system for student enrollment, follow-ups, and program information. Two new programs will be a system of professional review of selected materials by specialists in the State, and a computerized, cross-indexed catalogue of all materials and titles that are either in the RCU library or available elsewhere on request. (MM)

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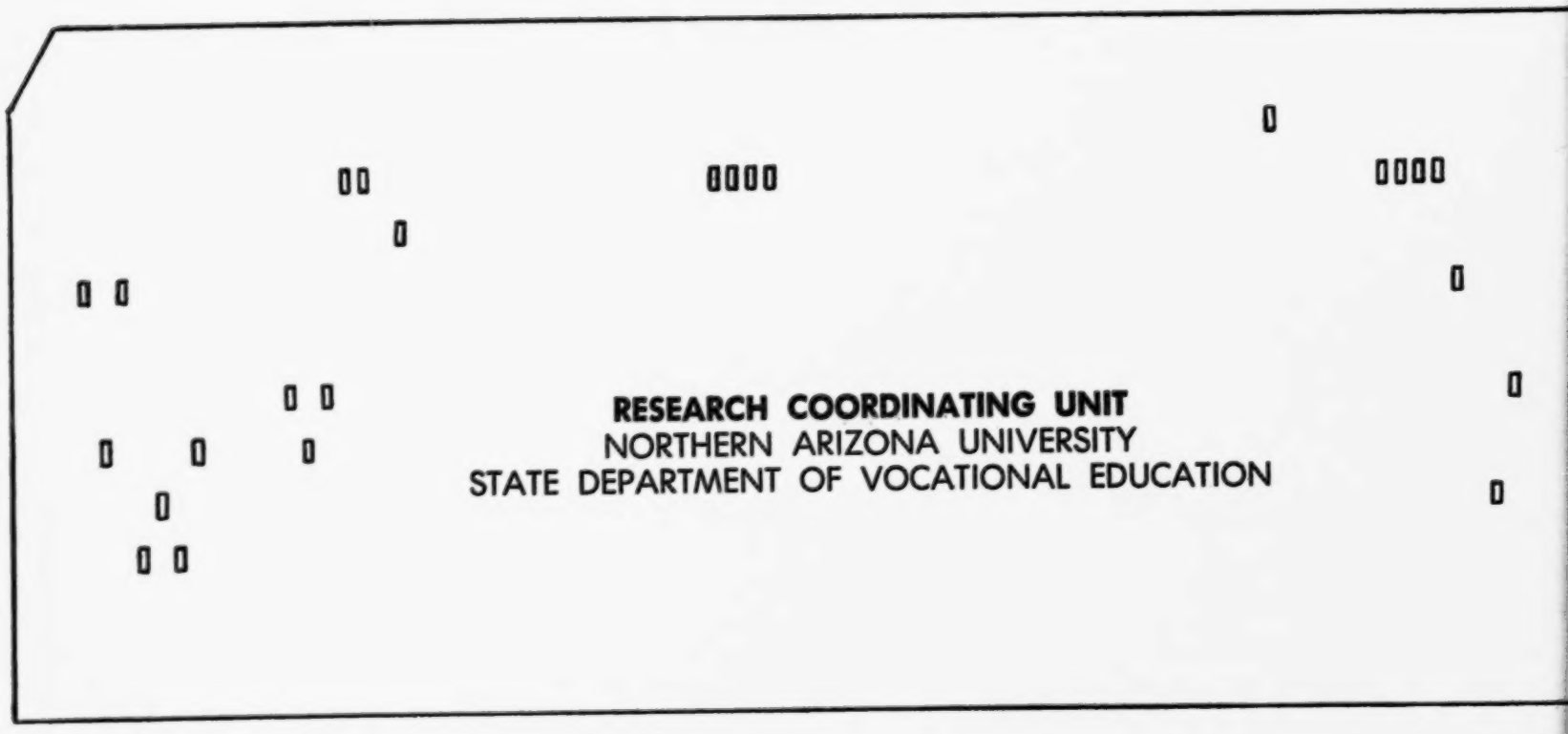

ANNUAL REPORT

JULY 1968

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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SECOND REPORT
ARIZONA RESEARCH COORDINATING UNIT

Project No. ERD-6-3029
Contract No. OEG4-7-063029-1595

Dr. Arthur M. Lee

July 1, 1968

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

Northern Arizona University

Flagstaff, Arizona

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INTRODUCTION

The Arizona Research Coordinating Unit was established by Northern Arizona University in 1965 in cooperation with the State Department of Vocational Education under a grant from the U.S. Office of Education. RCUs, as they are called, are located in forty-four states and are being added in the other six and in Puerto Rico. They are organized in state departments of vocational education, universities, research foundations, or other agencies, according to the preference of each state. Their functions are to develop and coordinate research in vocational and technical education in secondary schools, junior colleges, universities, business and industry and other public and private agencies. They form an interstate network of communications and research linked directly with the Division of Comprehensive and Vocational Education Research in the U.S. Office of Education, the Center for Research and Leadership Development in Vocational and Technical Education at The Ohio State University, the Center for Occupational Education at North Carolina State University, the Center for Studies in Vocational and Technical Education at the University of Wisconsin, and the Regional Educational Laboratories established by the U.S. Office of Education.

June 1965 - December 1966

During its first eighteen months the Arizona RCU placed major emphasis on (1) building a climate of vocational research in Arizona, (2) developing cooperation in vocational research between the universities, junior colleges, high school districts, state agencies, and employers, (3) providing technical assistance in research planning and design, (4) writing proposals for submission to funding agencies, and (5) providing liaison with Federal and other funding agencies. Approximately 200 research needs and suggestions were identified. Assistance was provided in writing proposals for about a third of these. Nineteen proposals were submitted to funding agencies, and twelve of these were approved.

More than four hundred persons were involved in Arizona's vocational research effort by the RCU during the first eighteen months. Significant inter-agency research cooperation was developed, especially in the health occupations, in manpower and employment needs, and in vocational research planning. A center of vocational research materials was established. A research newsletter for vocational educators was started. And a graduate level training program in vocational research was established by Northern Arizona University conducted by the RCU staff.

December 1966 - July 1968

When the second eighteen month period began, funding limitations forced a reduction in staff and made additional grants for new proposals virtually impossible. The Arizona RCU, therefore, concentrated on two major research projects while continuing to develop its collection of materials and its information services. The first project was a study of the educational requirements in engineering technology occupations. This selection was based on requests in Arizona from the three universities, several junior colleges, and major employers. The second project was a current study of vocational-technical education in the state as a basis for future planning.

METHOD

Engineering Technology Study

Planning conferences for this project, beginning in January, 1967, were held with administrators and faculty at each of the three universities, with the State Department of Vocational Education, with the State Employment Service, and with management personnel at Motorola, AiResearch, Mardian Construction Company, and Arizona Public Service. The project was designed, a PERT network drawn, and the procedures reviewed by an advisory panel of educators and industry representatives. An industrial survey was carried out in which 95% of the employers of engineering and technical personnel in Arizona and 35% of their employees participated. Another survey was made of students enrolled in engineering and engineering technology in the state's three universities and six junior colleges. A third survey was made of the curricula at each of these institutions. A synthesis of research in engineering technology, and an economic profile of the State, were undertaken. The information thus developed was analyzed in a book-length report. Twelve hundred copies were published in April, 1968, and distributed to educational institutions, state agencies, and national organizations.

Vocational-Technical Education Study

Planning conferences were held with the State Director of Vocational Education and his staff, with the university personnel, and with the State Employment Service. The project was designed, a PERT network developed, and considerable research initiated. Collection of data is now nearing completion, and portions of the report have been written. Publication and distribution are scheduled for January, 1969.

Library and Information Services

Vocational research reports, documents, data, and other materials coming to the attention of the RCU in the past three years have been collected, classified, and catalogued. These include materials distributed by other RCUs, the national vocational research centers, state and federal agencies, and publications purchased from the U.S. Printing Office and university and commercial publishers. All available microfiche on vocational-technical education distributed by ERIC and the Ohio State imput center have been purchased or ordered. Several bibliographical lists of vocational-technical materials have been acquired from other RCUs and from the Center for Studies in Vocational and Technical Education at The University of Wisconsin. These materials are being used by an increasing number of educators and researchers throughout the State.

Additional Activities

Assistance was provided by the RCU to several groups and educational institutions in the design and development of additional research projects: (1) to Maricopa Technical College in designing and preparing two demonstration proposals, one for $1.6 million to establish an allied health occupations center, and one for a little more than $100 thousand to establish an occupationally oriented approach to adult basic education; (2) to get a research proposal implemented in Cochise County which the RCU had previously designed. This project, estimated to cost in excess of $2.5 million was approved under Title III of ESEA; (3) and three projects in Yuma County -- a vocationally oriented cultural and language center, an agriculturally related employment survey, and a community economic development project.

Graduate students in each of the three universities have been encouraged to select theses and dissertations in vocational research through a stipend program administered by the RCU. Included have been a follow-up study of former distributive and office education students; an evaluation of the use of advisory committees in vocational-technical education; and the development of a model of technical curriculum development in the junior colleges.

A report on "Characteristics of Outstanding Engineering Technicians in Arizona," based on research carried out the previous year, was published and distributed.

Consultation services and assistance were provided to several agencies and institutions in developing vocational research related to the Indian population, including the Indian Development District of Arizona and the U.S. Bureau of Indian Affairs.

Conferences and Meetings

During the past eighteen months, the Arizona RCU was on the program of seven state or regional conferences and four national conferences. Arizona RCU personnel attended and took part altogether in nineteen state or regional meetings and eight national conferences.

RESULTS

Engineering Technology in Arizona

Since the major activity of the Arizona RCU in the past eighteen months has been the study of engineering technology, the results of that study occupy a prominent place in an assessment of the Unit's accomplishments. They are presented here in three major categories: (1) Information developed; (2) Recommendations; and (3) Actions resulting from the study.

1. Information Developed.

Work Experience: On-the-job work experience was found to be a major factor in the selection of careers in industry at every level, and a vital part of the education and training needed for such careers. Half of the engineering and technical students who responded to the student survey had been employed at some time in a job related to their educational program. More than one-fourth were working as technicians, engineers, or skilled craftsmen while attending school. Even among first year students, 42% reported previous related employment and 18% were employed at the time. One-fourth of the students in both engineering and technology said the major influence in their selection of a career was work experience. From 50% to 75% of the engineers, technicians, and skilled craftsmen contacted in the industrial survey had chosen their careers primarily because of work experience or the influence of someone else in the occupation.

The overwhelming preference of employers in filling new positions was found to be through promotion from within their own organizations or by pirating from other employers, presumably to get experienced people. Experience was reported as the major consideration in advancement in every field at every level, according to both employers and employees. The strongest recommendation by employers and employees in strengthening engineering and technical education was to give students more practical experience while in school. A substantial majority of employers said they favor cooperative work-study programs.

Need for Flexibility Educational programs at every level were found to need broadening, with an emphasis on flexibility. This was evident in strong recommendations by employers and employees to add both technical and liberal arts courses. Many of the recommendations stressed the need for greater flexibility in educational programs so that graduates could adapt more easily to the changes taking place in industry and increase their opportunities for successful careers. Reports of current research, professional studies, conference reports, and other published materials indicate a national trend in the direction of this conclusion.

In the industrial survey employers and employees in all occupations listed numerous educational courses which they feel are needed in preparation for the job but which are not directly related to activities associated with the job. The implications are that some kinds of knowledge are needed for each job that are not directly associated with the job, and also that virtually all industrial occupations are in a process of change. There is general agreement in industry that students preparing now for employment in the future will need additional kinds of knowledge.

This study also revealed a considerable extend of upward mobility in industrial employment. More than three-fourths of all engineers and technicians and one-half of the skilled craftsmen in the industrial survey expect to be working at higher occupational levels within ten years, while 29% of the technical students in Arizona schools plan to become engineers. Half of the technicians in the survey who are continuing their education -- and this includes a substantial majority -- are doing so to advance their careers. The manager of technical training and development in one of the largest companies in Arizona reported that 50% of their technicians were promoted to engineers last year.

Curricula Expansion: The most important direction in which curriculum expansion must take place in all educational programs seems to be communications, followed by business courses. Technical report writing is an activity associated with virtually all fields of engineering, most of the technical fields, and to some extent most of the skilled crafts. Reading, writing, and speaking rank next to mathematics as courses in which advanced knowledge is needed for engineering and technology and a general knowledge is needed for skilled employment. More general education, especially in communications and business was repeatedly and emphatically recommended in the personal comments from industry. The ASEE Goals Report and its critics both agree on the need to strengthen general education in engineering education, they disagree only on how it should be done. The importance of general education in technology and the skilled crafts is receiving major attention in research and professional literature.

One of the observations to be made from this study is the increasing importance attached to college degrees in both engineering and technology. A substantial number of employers prefer higher degrees than they require in all occupations. Many employers prefer baccalaureate degrees in technology, especially for aeronautical, chemical, data processing, electrical, geological, and metallurgical technicians. There are preferences for the doctorate in a few fields of engineering, and these are probably increasing. Much of the interest in continuing education is in earning higher degrees, and there is an apparent correlation between degrees and salaries in both technology and engineering. When they complete their present programs, 58% of the engineering students and 64% of the technology students in Arizona institutions who participated in the survey plan to continue their education toward a higher degree.

Non-Degree Technical Education: There is also evidence from this study that a great neglected area of non-degree education exists from which a substantial number of engineers and technicians are going into industry. The number of baccalaureate degrees in engineering remains the same each year while engineering services in industry are increasing. Nationally, three-fourths of the students enrolled in technology and two-thirds of those in engineering do not graduate. Nearly 40% of the associate engineers and technicians and 10% of the engineers in the survey of Arizona industry have some college but no degree. This non-degree, or less-than-degree, area is largely ignored by educators because their attention is focused on degree programs. Courses are arranged in sequences leading to degrees. There are non-degree programs in technology at Arizona State University, Northern Arizona University, and some of the junior colleges, but far more students drop out of degree programs than enroll in these. The educational institutions, for the most part, simply do not know either the kind of extent of their contribution to engineering technology through partially trained dropouts. Efforts to assist such students in making the most of their partial education are probably quite limited.

Continuing Education: One-half to three-fourths of all engineers and technicians, and nearly one-half of the skilled craftsmen in the survey of Arizona industry have taken additional courses in school. An analysis of current enrollments in the Phoenix and Tucson areas suggests that a substantial number of third and fourth-year students as well as graduates are either employed full-time and going to school part-time, or have returned to school after dropping out for one or more years. Much of the concern expressed by employees in their personal comments was over the need for more courses at night and in more

convenient locations.

School-Industry Cooperation: The study revealed a number of areas where industry and the schools should be more closely coordinated in their educational programs. Educators have no reliable information at the present time on either the kinds or extent of on-the-job training provided by industry for their graduates. Nor are systematic analyses made of the effect of work experience before, during, or after formal education programs. Industry has little knowledge of the students going into engineering and technology, their goals, strengths or weaknesses until they complete their education or an important part of it. Employers and employees both feel that engineering and technical faculties should have frequent exposure to industrial experience, and some of them feel that engineers and technicians should have classroom experience in the schools. Industry has only a vague idea of the purposes for which it supports continued education for its employees; and neither the schools nor industry make any appreciable effort at all to direct the great amount of such education toward specific goals.

This study revealed, however, a considerable interest on the part of both industry and the educators in Arizona to work more closely together. The review panel of educators and representatives of industry which assisted with the design of the survey and the evaluation of its results demonstrated a high degree of cooperation. Industry not only contributed substantially to the survey in personnel time and effort, but expressed an overwhelming interest in its purpose. A substantial number of employers took a position in favor of cooperative work-study programs. Educators, for their part, were equally interested in working with industry. The junior colleges have industrial advisory committees for most of their programs. Each of the universities has developed close working relations with major segments of Arizona industry. Each of the deans of engineering and technology at the universities and junior colleges and many of their faculty have participated in this study, as have the director and several supervisors in the State Department of Vocational Education and a number of high school administrators. The basis for increasing coordination between the schools and industry in educational programs at all levels is well established.

Manpower Needs: The Employment Service estimated a total employment at the present time in Arizona of 9,500 engineers, 7,270 technicians, and 6,120 skilled industrial craftsmen. These are estimated ratios of 5.3 engineers, 4.1 technicians, and 3.4 skilled industrial craftsmen per 1,000 population. The ratios are expected to increase slightly

by 1975 requiring an increase of 3,200 engineers, 2,480 technicians, and 2,280 skilled industrial craftsmen. It is not possible to project actual numbers of graduates from Arizona schools to meet these demands because individual industries do not know their future needs; graduates enter a national labor market rather than a state labor market, and demand exceeds the supply to such an extent that academic output cannot expect to catch up for some time to come. Nevertheless, it is possible to arrive at estimates of the average annual graduates needed based on the present output and Arizona's rate of industrial growth.

At the very least, Arizona schools should match the economic growth rate; but there are compelling reasons to attempt considerably more. Nationally the engineering schools graduate only about one-half the number of engineers needed each year, and this situation has prevailed for at least a decade. A similar annual deficit is found in technology education. In the skilled crafts automation tends to absorb some of the deficit, but attrition due to death and retirement is quite high and almost certain to go higher as the age level of these personnel continues to climb. Increasing national shortages of engineers, technicians, and skilled industrial craftsmen require that educational institutions in all states increase their annual output as rapidly as possible. Since Arizona's growth rate is approximately twice that of the nation as a whole, Arizona's schools should expect to assume a proportionately larger share of the responsibility of producing engineering and related personnel. National competition for this kind of manpower will require such an effort to sustain a favorable growth rate.

2. Recommendations to Schools and Industry.

Programs and Enrollment: The number of engineers, technicians and skilled craftsmen from Arizona schools will have to increase each year. By 1975 annual graduation figures should be 2,400 engineers, 2,400 technicians, and 2,550 craftsmen. In order to attract suggicient numbers of students to meet these demands, three courses of action were suggested:

(a) Continue to develop career-oriented guidance services in the high schools and colleges, supplemented by public relations programs by the colleges and industry. With assistance from the State Department of Vocational Education, the universities have added vocational guidance to their counselor education programs. High School counseling is receiving vocational emphasis in some schools with some counselors. Considerably more emphasis is necessary.

(b) Study the effect of present admission and graduation policies on both enrollment and retention of potentially capable engineers, technicians and skilled craftsmen. This is particularly important in regard to students with special problems. Determine to what extent social, economic, academic and other barriers to careers in engineering technology now exist, and find possible ways to remove them.

(c) Since work experience and exposure to industry are the major influences in attracting students to engineering and technology, develop a program of summer jobs in industry for high school students, graduates, and college students. Companies might develop such jobs for a given number of students, advertise them in the high schools, screen the applicants for achievement and aptitude, and stimulate considerable interest in engineering and technical careers.

Work Experience: Each of the universities and junior colleges should explore with industrial firms the most feasible means of incorporating work-study programs in their curricula. Three possible approaches might be made: summer internships between the second and third years, the third and fourth years, and the fourth and fifth years for students going on to graduate work; alternate semesters of course work and employment; and part-time employment during the third, fourth and fifth years. The employment in each case would need to be arranged by the school in such a way that the work experience would contribute directly to the educational program and would be coordinated with it. Experimental or pilot programs may be advisable at the beginning. Eventually, work experience should be a part of every student's curriculum.

General Education: In view of the apparent necessity to strengthen liberal arts in engineering and technology education, especially communications, it was suggested that realistic proficiency tests be developed by each institution to assist in guiding students individually into the courses they require. Such tests might be given to entering students and repeated at the beginning of each succeeding year. They need not be regarded as additional hurdles or obstacles, but merely used as the basis of guidance and counseling so that the students themselves are fully aware of their own deficiencies. They should certainly cover the principal areas of communications -- reading, writing, speaking, and graphics -- and may well include some basic economics, accounting, business management, statistics, history, sociology, psychology, political science, literature, philosophy, and art.

It was hoped that high schools will at the same time add industrial education in some form to the general education of all students, and encourage potential engineering and technology students particularly to take courses in this area.

(1) Curriculum Research. Solutions to the problem of expanding curricula were felt to be possible only through systematic research and experimentation. The colleges of engineering and technology were advised to initiate at this time curriculum research and experimentation along several lines: (1) The relationship of courses and course content to actual practice. No attempt was made in the present study at functional job analysis or coordination of subject matter in school with its need on the job except in a very general way. This was recommended. Efforts were suggested which would determine how much of the material in traditional courses, especially technical courses, is being used. Some courses may be streamlined, shortened, or combined with other courses to make way for additional instruction more relevant to industry's needs today. Since the technical courses make up one-half the curriculum, a considerable amount of subject matter may be scrutinized. As possibilities for streamlining and replacing materials appear, it was recommended that experimental curricula should be designed and tested.

(2) Experimentation to develop the concept of knowledge and proficiency as a basis for course credit rather than time spent in a classroom or laboratory was suggested. This would not be too difficult using computer technology. Almost any quantitative or qualitative level of achievement in most courses and at various intervals could be tested. The basic techniques have already been developed in teaching machines and flexible scheduling. There are serious problems involved, especially if common semester terminals in education are disrupted on an individual student basis. But it was felt there is no reason course work could not be speeded up or passed over altogether by dividing semester blocks of material into smaller modules and allowing students in a given course to proceed at their own pace. This would have the dual advantage of permitting good students to advance more rapidly through some courses thereby opening up opportunities for additional material, and allowing poor students to advance more slowly, thereby encouraging them perhaps to remain in school instead of dropping out. It would also open up possibilities for easier and more realistic transitions from technology to engineering for those students capable of becoming engineers.

(3) It was hoped that curriculum experimentation can also be instituted at the elementary and secondary levels which would introduce basic concepts and a foundation of knowledge in engineering technology to all students.

Student Follow-Up Data: A uniform automatic follow-up system for all institutions in the state using their own data processing equipment was recommended. Some follow-up information about graduates is available at each of the institutions, but at the present time it is difficult to gather and keep up-to-date. Techniques for automatic follow-up using computer technology have been developed in several states, and the Arizona State Department of Vocational Education is in the process of developing such a system. In addition to providing educators with more complete information and making it more readily available this would enable the schools to maintain closer contacts with former students. It would also enable them to follow-up students who do not graduate. In view of the rather considerable number who apparently benefit from a partial education, this kind of information should be available in designing curricula and in counseling students.

Continuing Education. All of Arizona's universities and junior colleges, and several of the high schools, have evening programs. The universities have extension courses in many parts of the state. Additional junior colleges are being built which will open up new opportunities for industrial personnel to continue their education. Yet this study indicated that more needs to be done. Two additional steps were recommended: (1) an inventory of evening and extension courses currently offered by all institutions; and (2) establish schools of continuing education in the universities with responsibility for complete degree and non-degree programs, which would be offered primarily in the evening both on-campus and off-campus.

A Master Plan: The information developed in this study was intended to be used in exploring more efficient and more effective ways of educating engineers, technicians, and skilled personnel for careers in industry. It was presented as a foundation upon which future planning may be based. Many of the states have made studies of their engineering programs or their technical and vocational programs and have arrived at plans for developing one or the other separately. The study itself indicated that educational planning at all levels should be closely coordinated between schools, school systems, and industry. On that basis a planning program was suggested for Arizona as follows:

(a) Each school individually should make an analysis and review of its programs using both faculty and representatives of industry on special review and planning committees.

(b) Individual school plans should incorporate as many of the suggestions from this report as seem feasible and advisable, including: new programs where they are needed; work experience in the curriculum; new combinations of courses based on occupational analysis; new concepts of regulating the time, sequence and content of degree programs; more general education, especially in communications and business; and provisions for continuing education equal to those for full-time students on the campus.

(c) Individual school planning programs should be coordinated for the state through the deans of engineering and technology. Regular channels of communications for this purpose should be maintained on a continuing basis, and periodic meetings of the deans should be held to assure a state-wdie program of education adequate for all the needs of engineering and technology.

(d) Recommendations of the school planning committees, and of the deans of engineering and technology meeting together, should be widely circulated for maximum coordination and participation by the schools, by other public agencies, and by industry.

Periodic Review: The information in this study is to be kept up to date on an annual basis, and are to be reviewed periodically. An annual conference on engineering technology, preceded by an updated supplement to the 1968 Report was recommended. It would provide an opportunity each year to re-examine old ideas and propose new ones. It would serve to hold the schools, the public agencies, and industry together in a common effort that involves them all. It would present to the public the progress and achievements to which each institution and company had contributed, and also the need for public support. It would allow educators, students, industrial management, and the public to share ideas and exchange viewpoints, assuring industry of the best product the schools can produce and the schools of the support they need in carrying out their responsibilities.

3. Actions Resulting from the Study.

Too little time has elapsed since publication of the Report to make an appraisal of its effect on engineering

technology in the State. Nevertheless, several actions are under way which suggest important results in the future. The report has received considerable attention and is being studied by an increasing number of educators and industrial management personnel. Requests for additional copies required a secondary printing after the initial 1,000 copies were distributed, and less than 100 copies of the second printing remain.

Many letters have been received, of which the following excerpts are representative. "Combining a spectrum of attitudes across all technical degrees, it presents a consolidated story, permitting a better understanding of technical manpower." -- Chairman, Engineering Manpower Commission, Engineers Joint Council. "It is most timely, indeed. It is a natural follow-up of the work we did on the Arizona Joint Economic Development Committee." -- Acting Director, College of Mines, University of Arizona. "It could not have come at a more opportune time and . . . will be an important tool in our development of Arizona." -- Vice President, First National Bank of Arizona. "An important contribution to educators and to us in the manpower services, as well as many others." -- Administrator, Arizona State Employment Service. "We feel that it will be of special use to the manpower section of IDD (Industrial Development Section)." -- Experiment Station, Georgia Institute of Technology. The Director of Research and Education of The Associated General Contractors of America received a copy from an Arizona contractor and wrote that he was already using it in advising personnel. The New York State Education Department requested a copy for New York University to be used in designing an engineering trade project.

A follow-up study of NAU graduates in industrial and vocational teacher education is planned for this fall with RCU support. All technology students enrolled in the six junior colleges are to be followed up this year by the RCU under a program sponsored by the State Department of Vocational Education. The Department of Technology at NAU has made a study of work experience in the curricula of other universities and colleges following the report to the Curriculum Committee for authorization to add such a program.

The Arizona Chapter of American Society of Certified Engineering Technicians has initiated a study of continuing education in Arizona institutions for industrial personnel, and the RCU will provide assistance. Arizona State University is continuing a program of curriculum experimentation and

development begun several years ago, some of which closely parallels recommendations made in the Engineering Technology report. Further research projects based on findings in the report are being designed by the RCU and will be submitted to the next meeting of the Arizona Vocational Research Council as follows: "Measuring Communication Needs of Engineering Technology Students"; "Designing an Experimental Program of Pre-Vocational Education in the Elementary and Junior High Schools"; "A Study of Continuing Education for Industrial Personnel in Arizona"; "Development of a Computerized Modular System of Course Components in Engineering Technology for Measuring Progress and Achievement"; "A Study of Socio-Economic and Other Handicaps Affecting the Admission and Retention of Engineering and Technology Students in the Universities and Junior Colleges of Arizona"; "Vocational Guidance in Engineering and Technology Through Computer Programming of Occupational Profiles"; "An Analysis of the Skills, Technical Knowledge and General Knowledge Required in a Technical Occupation."

Study of Vocational-Technical Education in Arizona

The results of this project will not be evident until after the report is published. However, some of the data collected were used by the RCU to publish a brochure on trained manpower in Arizona for the State Development Board entitled, Arizona Programs People Power for You. Additional data from this project have been prepared for the State Department of Vocational Education for program planning. Partly as a result of this project and directly related to it has been a joint undertaking by the State Department and the RCU to establish an automatic data processing system using electronic equipment for student enrollemtn, follow-ups, instructional staff and equipment in all vocational-technical programs in the State.

Results of Other RCU Activities

The Maricopa Technical College Proposal for an Allied health occupations education center was not approved for a grant by the U.S. Office of Education, but efforts are under way to carry it out with local support. Several curricula have been added to the occupational programs at MTC, including a career ladder concept in nursing education under which LPN's may become RN's. The adult basic education proposal has required additional preparation, and this is being provided by the College.

The Cochise County project is into Phase I, a one-

year planning program utilizing further assistance from the Research Coordinating Unit, the State Department of Vocational Education, the State Employment Service, and one or more of the universities. The County Administrators Advisory Committee made up of the ten high school superintendents and the administrator of technical education at Cochise College have agreed to develop under this project a completely new vocational-technical education program for the entire county. The initial grant of Title III funds, $30,000, has been received and a planning program for the next year has been adopted.

One graduate research project which the RCU supported this year was completed and published -- "Unemployment and Its Contributing Factors as Expressed by a Selected Group of 1967 Arizona Former Distributive and Office Education Secondary Students." Two others are not completed but are well along. Twelve graduate students from ASU and NAU, and five vocational and technical teachers from schools in Phoenix and Tucson have been used on the two research projects conducted by the RCU during the past year. All of the graduate students were on federally-sponsored work-study programs and were given training in research in connection with their work.

Between 1,500 and 2,000 titles in research reports and related materials have been collected in the Arizona RCU library. Approximately half of these are shelved, and the others are on microfiche. All materials are being catalogued and cross-indexed on magnetic tape for easy access through computer search and identification. The RCU offices adjoin the State Department of Public Instruction's data processing center and arrangements for extensive use of the equipment have been made. Increasing use of the RCU research library has been made by vocational educators and university students and faculty during the past year. This has been encouraged and supplemented by continued publication of the RCU newsletter.

The Arizona Vocational Research Council, organized during the first eighteen months, has been enlarged to approximately forty members. The Council meets quarterly to examine vocational research needs, review proposals, recommend research activities and suggest priorities. Its members include the technical administrators from all junior colleges in the State, several high school administrators, several members of the State Department of Vocational Education, the State Employment Service, representatives selected by the heads of Arizona's major industries,

and other industrial representatives. The Council has begun to make substantial contributions to vocational research, and serves as a vehicle for educators and employees to work together on common problems in manpower training.

DISCUSSION

Two previous grants from the U.S. Office of Education have taken the Arizona RCU through what might be termed its experimental stage. The need for permanent status was already recognized by the State Department of Vocational Education and Northern Arizona University when the U.S. Office made it effective through a continuation grant of five years beginning July 1, 1968. Congress, in the meantime, has followed a similar recommendation by the National Vocational Education Advisory Committee. New legislation passed by both the House and Senate provides research funds for the support of State Research Coordinating Units and projects recommended by such units.

In the Arizona RCU's Report of December, 1966, after eighteen months of operation several problems then facing vocational research were discussed. These were principally in the area of proposed writing and funding, and especially the coordination of actual research with research needs. Another problem encountered at that time was the great difficulty experienced by virtually all vocational researchers in getting adequate and reliable data from the schools. Program effectiveness, cost-benefits, and evaluation studies were too difficult or too expensive to undertake on any satisfactory scale.

The problem of proposal writing and funding was largely concerned with research needed at the state and local levels, and this has been met by the U.S. Office of Education through discretionary awards funds included in each RCU grant extension for the express purpose of supporting local research efforts. The 1968 amendments passed by Congress reaffirm and extend this action.

The need for student and program data in Arizona is now being met by the State Department's support of a uniform data collection and processing system operated by the RCU. The need for coordinating research with research needs is being met by the Arizona Vocational Council and also through increased visibility of vocational research in all educational institutions and all parts of the State.

Nationally a growing need for coordination, dissemination and diffusion of research was becoming apparent. This is being met through national and regional conferences of RCU personnel scheduled at regular intervals during the year. The importance of a number of national institutions is becoming increasingly apparent also in dissemination and coordination of research, especially The Ohio State University, The Center for Vocational and Technical Education; The University of Wisconsin, Center for Studies in Vocational and Technical Education; The Center for Occupational Education at North Carolina State University at Raleigh; The Rocky Mountain Educational Laboratory, Inc.

A problem which requires attention now is the growing volume of research materials available with no reliable way for educators to select those that are most useful. Two things are needed: a system of critical review and evaluation, and a highly efficient organization of materials to facilitate search and identification. The Arizona RCU will undertake during the next year to have those research reports which seem to have merit to be reviewed by specialists in the State. An attempt will thus be made to establish a dialogue about vocational research results coming out of the projects funded largely by the U.S. Office of Education in recent years. A much more extensive dialogue is needed. The best attempt by far is the publication of Human Resources by the University of Wisconsin. The publications committee of the American Vocational Education Association has recommended establishing a professional journal, and if this is done another very important and extremely valuable addition to such a national dialogue will have been added.

The problem of organizing vocational research materials nationally for easy access threatens to slow down the utilization of these materials for some time to come. ERIC is designed to perform this service, but even the supply of microfiche is far behind the publication of the abstracts. The delay seems to be longer under the new arrangements with National Cash Register than it was under Bell and Howell. It may be a matter of inadequate funds, but if so this has not been made clear to researchers and educators. Something needs to be done if ERIC is to gain the confidence of the educational community. It should, at the earliest opportunity, institute an automatic search and retrieval system possibly through remote control stations in each of the States. The RCUs could well serve as such stations.

In the meantime, the Arizona RCU is going ahead with its own system of putting all hard copies and microfiche in its library in an automatic cross-indexed identification and

and retrieval system. In addition, titles found in several current bibliographies are being key punched into the system. These include the University of Wisconsin bibliography in vocational education, the Review and Synthesis series published by the Ohio State Center, and several other state RCU lists. Just recently the decision was made to key-punch all materials abstracted in AIM and ARM, including those for which microfiche are not yet available, and the abstracts of research in progress being distributed by the Region IX research office and occasionally by the U.S. Office in Washington. It is hoped that Arizona educators and researchers can thus locate, for any purpose, through computer facilities available to the RCU, not only materials now in the RCU library but additional abstracts of recent materials, research projects underway, and other bibliographical references.

SUMMARY

The Arizona RCU has concentrated its efforts during the past eighteen months on a study of engineering technology, which was completed in a book-length report published in March of this year. Data collected and utilized in this report are being used by educational institutions, organizations, employers and other agencies throughout Arizona and in many other states. A second major project which is nearly completed, is a study of vocational-technical education in Arizona as a basis for future planning.

Other activities in the past eighteen months have included assistance with several research projects in the junior colleges and high schools, assistance in research design and proposal writing, collection and dissemination of research materials, development of a system of identifying research needs and priorities through a State Coordinating Council, and assisting the State Department of Vocational Education in setting up and operating an automatic data processing system for student enrollment, follow-ups, and program information.

Most of the problems which confronted the RCU eighteen months ago in the effort to develop and coordinate vocational research are now being met through actions by the U.S. Office of Education and Congress, by the State Department of Vocational Education and through new programs undertaken by the RCU. The major problems remaining at this time are lack of a national review and evaluation system to aid educators in selecting valuable research from the growing volume becoming

available, and the slow pace of ERIC in supplying microfiche and in developing an automatic search and retrieval system. Attempts to meet these problems in Arizona have resulted in two new programs being undertaken during the next year: a system of professional review of selected materials by specialists in the State; and a computerized, cross-indexed catalogue of all materials and titles that are either in the RCU library or available elsewhere on request.

CURRENT RCU ACTIVITIES

Added to the responsibilities of the Arizona RCU during the next year will be one other: designing and operating a complete state-wide record and data processing system for the State Department of Adult Basic Education. The advantages of a fully automatic procedure through which enrollment, program and student follow-up data are collected and processed using electronic equipment through a central professional agency have been apparent to the State Department of Vocational Education for some time. The addition of Adult Basic data processing is an attempt to extend these services to another important segment of the State's educational system closely related to vocational education. It is supported entirely by the State Department of Adult Basic Education and Northern Arizona University.

The complete program currently being carried out by the Arizona RCU is summarized below. The activities listed here are taken from the procedures sections of the RCU grant document and the Adult Basic Education grant document. They are divided into three major categories each requiring periodic or continuous allotments of staff time. Many of the activities are interrelated, and staff assignments are similarly interrelated.

All full-time staff positions in the RCU have assigned responsibilities, which may be changed as circumstances require. Final responsibility for all activities rests with the Director. Clerical work for each activity is the responsibility of the staff member in charge, assisted by other staff personnel and part-time enployees as needed.

Activities

1. Research Development.
   Identifying, generating, designing, coordinating,

and conducting research projects.

Vocational Research Council: Read and process proposals, ideas, and suggestions to be presented to the Council. Arrange and prepare agendas for quarterly meetings. Communicate with council members between meetings. Carry out recommendations of the council in writing proposals, locating research personnel and support, and setting up projects.

Grants and Stipends: Distribute lists of projects. Visit universities, junior colleges, and professional groups to create interest and provide information. Meet with individual students and faculty in setting up each project. Approve proposals, progress reports, and final reports. Disseminate results.

Proposals and Projects: Assist educators in planning research. Design projects requested by the State Director of Vocational Education and other State and University officials. Write proposals for additional grants and contracts. Arrange for professional consulting services in designing major projects for school districts, junior colleges, and the State Department of Vocational Education.

Advisory and Consulting Services: Meet with professional groups, state agencies, employers, and individual educators on projects and occasions involving occupational research. Attend State Vocational Education Department staff meetings. Schedule conferences with State Department and university personnel. Assist with major on-going research programs in Cochise County, Yuma County, Pima County, Maricopa Technical Institute, Phoenix Union High School, and at other locations as they are developed.

Out of State Coordination: Attend national and regional meetings of research coordinating units. Attend national conferences and meetings arranged by the U.S. Office of Education, by the vocational research centers at Ohio State, North Carolina State, and Wisconsin Universities, and by the American Vocational Education Research Association. Serve on vocational projects conducted by the Rocky Mountain Educational Laboratory, Inc. Provide ERIC and other national centers with Arizona research reports and materials. Maintain liaison with each of these agencies through correspondence, telephone and personal conferences.

RCU Research: Carry out projects especially needed in Arizona within RCU capabilities, such as the study of

engineering technology completed last year and the study of vocational-technical education to be completed this year. Carry out additional research suggested in previous findings and in the development of educational data. Develop procedures for cost-benefits studies and program efficiency analyses.

2. Data Development.

Vocational-technical, adult education, manpower and employment, and career selection.

Vocational-Technical Data: Design forms and procedures for collecting data on student enrollment, follow-up, curriculum, facilities, equipment, and costs. Distribute forms, check returns, and keypunch. Follow-up non-returns by mail and telephone. Design computer analyses and print-out tables. Publish and distribute reports.

Adult Education Data: Design forms and procedures for collecting data on student enrollment, attendance, achievement, follow-up, curriculum, and costs. Distribute forms, check returns, and keypunch. Follow-up non-returns by mail and telephone. Design computer analyses and print-out tables. Publish and distribute reports.

Manpower and Employment Data: Design employer questionnaires for periodic surveys of Arizona industry. Update industrial employer mailing list, mail questionnaires, check returns, follow-up by additional correspondence and telephone, and keypunch. Design computer print-out tables. Write, publish and distribute annual supplements to Engineering and Technology in Arizona. Conduct additional manpower and employment surveys in Arizona through cooperative arrangements with the State Employment Service. Gather and catalogue employment, manpower and economic data from the U.S. Bureau of Labor Statistics, Commerce Department, State Employment Service, Arizona Financial Institutions, universities, and other sources available.

Career Selection Data: Design and field test a student information system for vocational guidance using automatic data processing. Develop occupational profiles for computer matching with student data.

3. Research and Data Dissemination.

Library services, newsletter, reports, conferences, and symposiums.

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Career Selection Data: Design and field test a student information system for vocational guidance using automatic data processing. Develop occupational profiles for computer matching with student data.

3. Research and Data Dissemination.

Library services, newsletter, reports, conferences, and symposiums.

Library and Information Services: Collect, catalogue and shelve all vocational-technical materials available from federal agencies, national centers, educational laboratories, other RCU's, universities, and State agencies. Collect abstracts and microfiche on vocational-technical education listed in Research in Education; Abstracts of Research Materials; and Abstracts of Instructional Materials. Classify, cross-index and keypunch shelved materials, abstracts and microfiche. Classify, cross-index and keypunch microfiche received by the State Department of Adult Education. Classify, cross-index and keypunch vocational-technical materials listed in bibliographical guides. Locate research materials through computer search and printout. Compile lists of research reports and materials available for distribution to vocational educators in the State. Arrange, publish and distribute professional reviews of significant research reports. Send abstracts, and notices of research results to individuals in the State in a position to use them. Correspond with high school, junior college, and university libraries in developing local collections of microfiche and vocational research materials. Develop use of RCU library facilities including duplicating services and microfiche reader by students, faculty and researchers. Process RCU library loans. Arrange for purchase of microfiche and published materials on request.

Newsletter: Write news articles on vocational research activities and findings. List significant research reports. Reprint significant research information from other RCU's and state and federal agencies. Revise mailing list periodically. Design, reproduce and mail.

Quarterly and Annual Progress Reports: Compile lists of research activities, reports and results developed in this office. Write descriptive reports, reproduce and distribute to selected mailing lists.

Annual Conference on Engineering Technology: Arrange date, location, and physical details. Plan program including speakers, institutional reports, conference sessions and conference report in consultation with advisory committee. Develop list of participants, send out invitations, and arrange for news coverage. Arrange for conference staff assistants. Conduct the conference. Publish and distribute conference report.

Research Symposium: Plan, schedule and conduct several research symposiums annually. Select significant research reports to be studied. Arrange for professional

reviews and presentations. Invite participants from among vocational educators, employers, and administrators. Record symposium discussions, transcribe and write up the results. Publish and distribute reports.

STAFF ASSIGNMENTS

Major responsibility for each activity is assigned to only one person. Assisting responsibility is assigned to one or more persons, or to none.

Director

Final Responsibility For All Activities.

Major Responsibilities: Vocational Research Council, Grants and Stipends, Proposals and Projects, Advising and Consulting Services, Out of State Coordination, RCU Research, Newsletter, Quarterly and Annual Progress Reports, Financial Records.

Coordinator

Major Responsibilities: Vocational-Technical Data, Adult Education Data.

Assisting Responsibilities: Advisory and Consulting Services, Out of State Coordination, RCU Research.

Research Assistant

Major Responsibilities: Manpower and Employment Data, Career Selection Data.

Assisting Responsibilities: Library and Information Services, RCU Research, Vocational-Technical Data, Adult Education Data, Annual Conference on Technology, Research Symposiums.

Librarian

Major Responsibilities: Library and Information Services.

Assisting Responsibilities: Vocational-Technical Data, Adult Education Data, Manpower and Employment Data, Career Selection Data, Research Symposiums.

Director's Secretary

Major Responsibilities: Annual Conference on Technology, Research Symposiums, Office Equipment and Supplies, Temporary and Part-Time Personnel.

Assisting Responsibilities: Newsletter, Quarterly and Annual Progress Reports, Financial Records, Director's Activities.